

The potential social, economic and environmental benefits of MOOCs: operational and historical comparisons with a massive “closed online” course

Andy Lane, Sally Caird & Martin Weller

The Open University (United Kingdom)

andy.lane@open.ac.uk, sally.caird@open.ac.uk & martin.weller@open.ac.uk

Abstract

Massive Online Open Courses (MOOCs) have recently become a much discussed development within higher education. Much of this debate focuses on the philosophical and operational similarities and differences between the types of MOOCs that have emerged to date, the learner completion rates and how they can be sustained. In contrast there has been much less discussion about how such courses do, or do not, fit in with existing higher education policy and practice in terms of the social, economic and environmental benefits. This paper begins to address this issue by comparing and contrasting current MOOCs with one large population ICT-enhanced, mostly online Open University UK course presented a decade earlier and how they have both served, or might serve, broader social, economic or environmental objectives. The paper concludes that while MOOCs are forcing a re-conceptualisation of higher education study, much can also be learned from previous and existing large population mainly online courses from open universities.

Keywords: MOOCs; online education; policy and practice; environmental impact; social impact; economic impact

Introduction

Massive Online Open Courses (MOOCs) have become a much discussed development within higher education (HE) under the aegis of open education (Daniel, 2012). Only recently have they burst upon a wider public consciousness (Universities UK, 2013) and attracted significant policy attention. In one sense MOOCs are a technology-enabled development of the slightly longer-lived open educational resources (OER) movement to support life-long learning (Lane, 2012). In another sense they represent an opening up of a burgeoning online education effort being used with traditional students within higher education institutions (HEIs) to enhance the teaching and learning experience (Johnson *et al.*, 2012; Yuan & Powell, 2013; McAndrew & Scanlon, 2013). Many different forms and style of MOOCs have appeared which vary in how many students they attract, how open they are according to the philosophy of the Cape Town Open Education Declaration (2007), whether all activity is online and even whether it counts as a course or a connected community (Daniel, 2012; Rodriguez, 2013). Rather than follow a hard definition of what is a MOOC we examine some of this ambiguity through a comparison of some aspects of MOOCs with their nearest historical equivalents.

Various claims and counter claims about the role and significance of MOOCs for HE have been made in online media (e.g. Boxall, 2012; Craig, 2012), including their degree of openness to users and their perceived role to widen access to higher education in both developed and developing countries (Liyanagunawardena *et al.*, 2013a; 2013b). Much of this debate focuses on the philosophical, pedagogical and operational similarities and differences between the types of MOOCs that have emerged to date (Universities UK, 2013; Rodriguez, 2013) although nearly all are free to

participants with no upfront fee, and all are open entry, in that no prior qualifications are required of the enrollees (although many do stress the expected level of prior attainment).

While there has also been much debate on whether MOOCs will disrupt HEIs, have satisfactory completion rates and build on sustainable financial models, there has been much less discussion about how such courses do, or do not, fit in with existing policy and practice of increasing participation rates in HE, of widening participation to members of society that have not traditionally participated in higher education, and of supporting completion of higher education qualifications (e.g. OECD, 2013; EU, 2012). However two recent reviews by one of us (Lane, 2013a; 2013b) examined these broader societal and governmental aims with the past experiences of achieving those aims through open and distance learning courses operated by “open” universities around the world. This paper summarises those two reviews and adds another dimension—environmental impacts. The growing drives for HE to meet environmental as well as social and economic targets (Tilbury, 2011) also make it important to consider whether MOOCs have better or worse environmental impacts than other models of delivering HE teaching and learning. Nothing as yet is being researched on the attendant environmental impacts of MOOCs, while there has been little such research into the environmental impacts of existing HE course models, with the exception of the Factor 10 and SusTEACH (<http://www.open.ac.uk/blogs/susteach>) projects that were conducted by Open University of the United Kingdom (OUUK) research teams in the past 10 years (Caird *et al.*, 2013).

This paucity of research data will no doubt change but in their absence it can help to direct data collection and research on “non-formal”, fully online MOOCs through a considered comparison of these new forms of online courses with the research data available from their nearest equivalents—“formal”, mainly online courses run by “open” universities—and in particular The OUUK (McAndrew & Scanlon, 2013). The aim of this paper is therefore to review what is currently seen as the widening access and environmental policy objectives for HE, and to compare and contrast the ways in which MOOCs and their open university counterpart courses with large student populations serve or might serve those policy objectives. It does so by building upon the social, economic and environmental data that have previously been applied to mainly online courses and OERs from The OUUK, in particular a pioneering open entry, fee paying Information and Communication Technologies (ICT)-enhanced course entitled *T171 You, Your Computer and the Net* that regularly had thousands of students for each presentation from 2000–2005 (Mason & Weller, 2000; Weller, 2000; Weller & Robinson, 2002). It both compares and attempts to extrapolate these now historical data to recently published data on MOOCs to identify similarities and differences. We look firstly at the issues around widening participation, followed by those around environmental impacts, and finishes by drawing out some conclusions on future research directions.

Social and economic objectives: widening participation in higher education

As described in more detail by Lane (2012, 2013a) widening participation in HE has different dimensions. OECD regularly publish data on the proportion and type of people completing specified levels of education although without information on the numbers that participate for some period but do not “complete” a particular level (e.g. OECD, 2013). The report is clear about the benefits of educational attainment:

Higher levels of educational attainment are strongly associated with higher employment rates and are perceived as a gateway to better labour opportunities and earnings premiums. Individuals have strong incentives to pursue more education, and governments have incentives to build on the skills of the population through education, particularly as national economies continue to shift from mass production to knowledge economies. (OECD, 2013, p. 28)

While it follows that widening access to, and attainment in, higher education has both a social and an economic dimension, as noted in this quote, the levels of educational attainment in a particular population may hide great inequalities in the opportunities to do so throughout all sectors in society.

Inevitably, as outlined by Lane (2012), the chance to participate is constrained firstly by the absolute *availability* of places for study within a country (e.g. the number of higher educational institutions and the capacity of those institutions to teach students). It is constrained secondly by the *affordability* of opportunities (for instance study may involve great costs) and thirdly by its *accessibility* (such as being taught in a second or third language for the student or involving significant travel or assuming advanced student knowledge at the course beginning). Fourthly there is a question of *acceptability* of the opportunities on offer (for example the provision may be of poor quality, have an implied bias in the intellectual position taken by the teachers or it may be in subjects that prospective students do not want to study). Nevertheless, even where provision is available, affordable, accessible and acceptable, it may not be taken up by some less privileged groups in society for other wider, physical, social, psychological and cultural reasons.

The newness of MOOCs, coupled with logistical difficulties in getting either pre-enrolment or exit data on the participants, means that it is difficult to compare MOOCs from different providers, let alone make comparisons with fee-based large online courses. However two sources give some early indications of who is attracted to these MOOCs and how do those "students" perform.

The first source of data on MOOCs and their student characteristics comes from a researcher, Katy Jordan (2013) who has been working to aggregate any published information on MOOCs, and in particular, the stated completion rates where there are different assessment modes and where the course length varies (see also Jordan, 2014). The second source is a report from the University of Edinburgh (Edinburgh @ MOOCs Group, 2013) who have run six MOOCs through Coursera (<https://www.coursera.org>) and surveyed "students" on entry and, where possible, on exit from those courses (a more recent University of London Report, 2013, confirms the main trends noted here).

It is tricky to draw very firm parallels between current day MOOCs and their fore-runner massive ICT-enhanced, mainly online courses within open universities. Nevertheless, there are a number of similarities and differences which it is worth commenting on, particularly in relation to access and achievement in higher education study.

First, the student demographics show that the age profiles were similar. Interestingly 75% of MOOC participants were doing their first MOOC while about 70% of T171 students were new to the OUUK and thus online and distance learning. Geographical dispersion differed, as the MOOCs attract more people from different countries than was the case with T171 who were mostly UK based.

Second, while both are open entry, the fee for a credit bearing course tied to teaching grant support from an HE funding council, plus the nature of tuition and support from regional centres, means the OUUK course was much more geographically-focussed (most students were from the UK). Whilst some MOOCs charge fees for credits none offer the place-based network of tutorial support, and instead provide all tutorial support online.

Third, most T171 students were signing up for a long duration course lasting 32 weeks (in contrast most MOOCs last ten weeks or less).

Fourth, for T171, like many early MOOCs, the medium was the message. The extensive interest by large numbers of people that surprised the early course providers in both cases was in learning about subjects that related very much to computers and communications technologies. In both cases too, online courses have quickly moved into many other disciplines.

Fifth, interest in the topic seemed to be a prime motivating factor rather than any vocational or job-related factors. However, whereas that interest in MOOCs has been mostly with the already

well-educated, the interest in the OUUK course was from as diverse educational backgrounds as most other OUUK courses, with up to 40% having low previous educational qualifications. The fact that this course was clearly part of the existing credit-bearing provision aimed at opening up opportunities to attain qualifications rather than a separate adjunct to it, might account for some of this difference in educational backgrounds.

Sixth, completion rates (35–50%) were much higher for the OUUK course than nearly all MOOCs to date (5–20%). Again, the fact that T171 was part of existing credit-bearing provision would account for this as well as the higher levels of direct tutorial support provided by Associate Lecturers compared to the much lower levels of personal support given in MOOCs, mainly provided through peer interaction. In fact there are many different logistical challenges associated with the T171 provision for large numbers of students as noted by Weller and Robinson (2001) and Mason and Weller (2000).

Accepting the limitation of comparing data from different sources, at different times, using different categorisations, it is fair to conclude that MOOCs do not appear to help meet the main social and economic objectives set out for HE as they support the already-privileged over the less-privileged in contrast to the T171 OUUK example. However, MOOCs are not products of national and international policy and so cannot be expected to be designed to meet that need without further research and thought given to the roles they might play. Nevertheless, if they were to be assimilated into such policy frameworks then much more attention would need to be given to how MOOCs fit into educational systems in general and the open education movement in particular.

As noted by Lane (2013b) open education is driven by a fundamental reciprocal desire to share knowledge and ideas at various scales amongst individuals, organisations and nations alike. Aided by digital technologies, the extent of open education represents a balance between the need to provide education as an organised and regulated business (the economic aspects), and education as a public good (the social aspects). In essence open educational systems offer the potential to break the iron triangle of access, cost and quality that apply to education and create more flexible forms of provision alongside the existing more traditional but rigid forms (Daniel & Uvalic-Trumbic, 2011).

The advantages of open education are particularly apparent when consideration is given to the relatively fixed costs of the physical infrastructure of schools, colleges and universities and the number of teachers they employ due to the relatively small cohorts that each teacher can manage to teach successfully (there are many debates worldwide about optimum class sizes and effects on pedagogic quality [e.g. see Kokkenlenberg *et al.*, 2005] but the physical limitations of most existing classroom sizes in expensive buildings and their occupancy rates are universal). This physical infrastructure is equally a major factor in determining environmental impacts.

Environmental objectives: lowering carbon impacts

As noted earlier, all HEIs are expected to contribute to sustainable development and reducing their environmental impacts (Tilbury, 2011). Nevertheless very little attention has been paid to the direct (and indirect) impacts of HE teaching models except by the OUUK.

If we examine the results of a carbon-based environmental assessment of a large population course such as T171, we can compare the impacts of the ICT-enhanced distance teaching model used to teach this course with the impacts associated with using other teaching models. From this we can extrapolate to consider the likely environmental impacts of fully online MOOCs.

The environmental impacts of T171 were first examined within the Factor 10 Visions study (Roy *et al.*, 2008), and then subsequently reanalysed as part of the SusTEACH project using the latest

measures of energy consumption and carbon conversion factors (Caird *et al.*, 2013). This involved an assessment of the main sources of HE course-related energy consumption and carbon emissions, including travel, the purchase and use of ICTs, the consumption of paper and printed materials, residential energy and campus site operations. A large sample of 846 students responded to surveys about their course-related activities on T171 and 55 staff provided information on the course production and initial presentation. Data analysis was supported by energy databases and energy assessment software, and the development of a classification of teaching models using a range of teaching methods including ICTs, face-to-face teaching and classic distance teaching methods. The results for each area of environmental impact were converted to measure the average energy consumption and CO₂ emissions of a course per student/per 10 CATS credits (i.e. equivalent to 100 hours of study) (The Open University, 2014).

As nothing has been researched so far on the attendant environmental impacts of MOOCs, the detailed analysis of the large population mainly online course T171, and findings of the SusTEACH project have implications for considering the likely environmental impacts of MOOCs. T171 can be described as having a blended ICT-enhanced distance teaching model rather than being primarily delivered online. Teaching materials were accessible via a dedicated course website that partially replaced the course books, audio-visual materials and assignments that had previously needed to be printed and distributed, although students continued to receive two printed set books by post. Whilst an ICT-enhanced tuition and assessment system replaced the need for travel to examination centres and to attend face-to-face tutorials, students continued to attend at least one face-to-face tutorial. T171 is therefore a blended course using a mix of online, classic distance and face-to-face teaching methods.

The SusTEACH project compared four ICT-enhanced courses with four online courses and fourteen mainly face-to-face taught courses. The online courses had an almost fully online teaching, learning and assessment provision together with some minimal face-to-face day school provision. The findings showed that HE online and blended ICT-enhanced distance teaching models had significantly lower impacts than face-to-face teaching models (Caird *et al.*, 2013). It is evident from Table 1 that the main sources of carbon emissions were associated with travel, residential energy and campus site operations. The use of online and ICT-enhanced distance teaching models reduced carbon emissions by reducing the requirements for students to travel to classrooms; establish additional residential accommodation away from their main home; and use campus facilities.

Table 1 compares the carbon impacts associated with T171 as an example of an ICT-enhanced distance-taught course, with courses taught using traditional face-to-face teaching and online teaching models. The analysis showed that T171 achieved strikingly lower overall carbon impacts that were 81% lower than those associated with a face-to-face teaching model. More significantly

Table 1: Average CO₂ emissions (kg) of T171 in comparison with Face-to-face and Online teaching models (per student per 100 study hours)

Average CO ₂ emissions (kg)						
	Travel	ICTs	Paper, print, and other materials	Residential energy	Campus site operations	TOTAL
Face-to-face	129	4	11	57	77	278
T171	8	14	9	6	16	52
Online	2	13	4	1	16	36

in terms of implications for MOOCs, carbon reductions of 87% could be achieved by replacing face-to-face teaching with a primarily online teaching model.

Further insights into considering the likely carbon-based environmental impacts of MOOCs may be gained by comparing the emissions associated with the T171 course with courses primarily produced and delivered online. The data in Table 1 shows that online models can achieve reductions in carbon emissions of 31% compared with T171, mainly as a result of reducing student travel and the consumption of paper and printed materials. The reduction or elimination of face-to-face tutorials explained why students taught mainly online travelled on average only 8 miles per 10 CATS credits compared with the 33 miles travelled by T171 students per 10 CATS credits. Furthermore, reduction both in the production and transportation of delivered course materials, and printed books purchases explained why students taught mainly online had lower paper and printed materials consumption per 10 CATS credits than T171 students. An unexpected finding was that students taught mainly online consumed on average more paper (195 sheets) per 10 CATS credits than T171 students (169 sheets). This may be explained by a preference of many students to print online materials rather than read on-screen. As the consumption of paper and printed materials for other purposes was low by students taught online, this supports the contention that online delivery of course materials may increase printing, despite lower overall average CO_2 emissions.

These findings inspire confidence that the online delivery of MOOCs should achieve lower carbon emissions in comparison with other models of delivering HE teaching, as MOOCs can eliminate the need for student travel and residential accommodation, and reduce the use of campus accommodation and facilities. We would therefore expect that the carbon emissions associated with MOOCs to be lower than the online teaching model's average carbon emissions of 36kg per student per 10 CAT credits as this includes some day school travel impacts, albeit allowing for possible rebound effects that might manifest. Furthermore, the energy consumption and carbon emissions associated with the production and delivery of MOOCs are expected to be extremely low compared with other teaching models when calculated per student, as by definition MOOCs offer education on a large scale to massive student populations and therefore can achieve scale efficiencies. However these calculations may be confounded by the lower levels of participation and completion in MOOCs.

Conclusions

This paper has raised as many questions as answers around some of the social, economic and environmental benefits of MOOCs.

If MOOCs attract and suit a well-educated audience, should they be used simply for lifelong learning or as a prelude to postgraduate studies? How can MOOCs be designed to develop their potential to widen participation beyond existing well-educated students? Should they aim to be more vocational and serve a continuing professional development agenda? If so, then developing mechanisms for accreditation and qualification award as well as pedagogical quality standards becomes the priority. In addition, will MOOCs be mainly a test-bed for pedagogical developments using online technologies? If nothing else these questions need to be framed within the growing policy focus on open education in general¹ and policy-focussed reports (e.g. Falconer *et al.*, 2013).

On an economic front, does it matter if completion rates are low when the provision is free? Arguably it does, as it weakens the impact of MOOCs which powers the case for policy support at institutional, national and international levels. Whether MOOCs are free at the point of delivery they nonetheless have a production cost. Completion rates may be inversely related to zero-cost courses as people may have difficulty valuing what they get free. Would more people complete if they paid a small fee and is a different business model needed?

For learners, education can provide both economic and social returns on the investment of time and money that they make. To justify the increases in tuition fees many governments and other agencies highlight the personal economic returns on education and particularly higher education (see, for example, OECD, 2012). This usually relates to improved career prospects and higher lifetime earnings. However, researchers are now trying to widen the debate on returns on investment by trying to estimate the social returns on investment (SROI) for adult education in the UK (Fujiwara, 2012). The key findings of this study are: "Participating in adult learning is found to have significant positive effects on individual health, employability, social relationships, and the likelihood of participating in voluntary work. In turn these domains have positive impacts on individual well being" (p. 2).

Such modelling is new and subject to much debate but it would be valuable to apply SROI to MOOCs.

Lastly, whilst MOOCs are likely to have low environmental impact there is a need for research to assess the additional or reduced impacts of campus site operations involved with external-facing MOOC provision, as well as other impacts of MOOC based course activities that offer supplements or replacements to face-to-face based activities for formally registered students. There is also a greater need to account for the environmental impacts of teaching within the sustainability reporting of HEIs.

This paper concludes that MOOCs are forcing a re-conceptualisation of higher education through the use of online study amongst all universities that was previously mainly found in "open" universities. While the scope of that re-conceptualisation in the literature has been focussed on business and pedagogical models within HEIs, we argue that more focus is needed on the wider social, economic and environmental impacts for regions and nations. We also conclude that "non-formal" massive online courses need to be more closely examined for how they might better serve national and international policy through making comparisons with their "formal" counterparts within open universities, and that research effort needs to be directed at this issue.

Acknowledgment

This paper was presented at the 2014 OpenCourseWare Consortium Global Conference, held in Ljubljana (Slovenia) in April 23th-25th 2014 (<http://conference.ocwconsortium.org/2014>), with whom *Open Praxis* established a partnership. After a pre-selection by the Conference Programme Committee, the paper underwent the usual peer-review process in *Open Praxis*.

Note

¹ Such as that at <http://openeducationeuropea.eu/>

References

Boxall, M. (2012, August 8). MOOCs: a massive opportunity for higher education, or digital hype? *The Guardian*. Retrieved from <http://www.guardian.co.uk/higher-education-network/blog/2012/aug/08/mooc-coursera-higher-education-investment>

Caird, S., Lane, A. & Swithenby, E. (2013). ICTs and the design of sustainable higher education teaching models: an environmental assessment of UK courses. In S. Caeiro, W. Leal Filho, C. J. C. Jabbour & U. M. Azeiteiro (Eds.). *Sustainability Assessment Tools in Higher Education—Mapping Trends and Good Practices at Universities Around the World* (pp. 375–386). Springer International Publishing Switzerland.

Cape Town Open Education Declaration. (2007). *Cape Town Open Education Declaration: Unlocking the promise of open educational resources*. Retrieved from <http://www.capetowndeclaration.org/read-the-declaration>

Craig, R. (2012, August 31). Elitism, equality and MOOCs. *Inside Higher Ed*. Retrieved from <http://www.insidehighered.com/views/2012/08/31/massive-open-courses-arent-answer-reducing-higher-ed-inequality-essay>

Daniel, J. (2012). Making Sense of MOOCs: Musings in a Maze of Myth, Paradox and Possibility. *Journal Of Interactive Media In Education*, 3(0). Retrieved from <http://jime.open.ac.uk/jime/article/view/2012-18>

Daniel, J. & Uvalic-Trumbic, S. (2011). The impact of new business models for higher education on student financing. *Financing Higher Education in Developing Countries Think Tank*, Bellagio Conference Centre, Las Vegas, 8–12 August, 2011. Retrieved from <http://www.col.org/resources/speeches/2011presentation/Pages/2011-08-08.aspx>

EU. (2012). *The European Higher Education Area in 2012: Bologna Process Implementation Report*. Retrieved from [http://www.ehea.info/Uploads/\(1\)/Bologna%20Process%20Implementation%20Report.pdf](http://www.ehea.info/Uploads/(1)/Bologna%20Process%20Implementation%20Report.pdf)

Falconer, I., McGill, L., Littlejohn, A. & Boursinou, E. (2013). *Overviews and Analysis of Practices with Open Educational Resources in Adult Education in Europe*. Luxembourg: Publications Office of the European Union. Retrieved from <http://ftp.jrc.es/EURdoc/JRC85471.pdf>

Fujiwara, D. (2012). *Valuing the Impact of Adult Learning: An analysis of the effect of adult learning on different domains in life*. Leicester: National Institute of Adult Continuing Education (NIACE). Retrieved from <http://shop.niace.org.uk/valuing-impact.html>

Johnson, L. Adams, S. & Cummins, M. (2012). *The NMC Horizon Report: 2012 Higher Education Edition*. Austin, Texas: The New Media Consortium. Retrieved from <http://www.nmc.org/pdf/2012-horizon-report-HE.pdf>

Jordan, K. (2013, February 13). Synthesising MOOC completion rates. *MoocMoocher*. Retrieved from <http://moocmoocher.wordpress.com/2013/02/13/synthesising-mooc-completion-rates>

Jordan, K. (2014). Initial Trends in Enrolment and Completion of Massive Open Online Courses, *International Review of Research on Open and Distance Learning*, 15(1), 133–160. Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/1651>

Lane, A. (2012). A review of the role of national policy and institutional mission in European Distance Teaching Universities with respect to widening participation in higher education study through open educational resources, *Distance Education*, 33(2), 135–150. <http://dx.doi.org/10.1080/01587919.2012.692067>

Lane, A. (2013a). The potential of MOOCs to widen access to, and success in, higher education study. *The Open and Flexible Higher Education Conference 2013*, 23–25 October 2013, Paris, EADTU, pp. 189–203.

Lane, A. (2013b). Social and economic impacts of open education, in A. Meiszner & L. Squires (Eds.). *Openness and Education (Advances in Digital Education and Lifelong Learning, Volume 1)*, 137–172, Emerald Publishing. [http://dx.doi.org/10.1108/S2051-2295\(2013\)0000000006](http://dx.doi.org/10.1108/S2051-2295(2013)0000000006)

Liyanagunawardena, T., Williams, S. & Adams, A. (2013a). The impact and reach of MOOCs: A Developing Countries' perspective. *eLearning Papers*, 33, Retrieved from <http://www.openeducationeuropa.eu/en/download/file/fid/26956>

Liyanagunawardena, T., Adams, A. & Williams, S. (2013b). MOOCs: A systematic study of the published literature 2008–2012. *International Review of Research on Open and Distance Learning*, 14(3), 202–227. Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/1455/2531>

OECD. (2012). *Education Indicators in Focus*. Retrieved from <http://www.oecd.org/edu/skills-beyond-school/Education%20Indicators%20in%20Focus%206%20June%202012.pdf>

OECD. (2013). *Education at a Glance 2013: OECD Indicators*. OECD Publishing. Retrieved from <http://www.oecd.org/edu/skills-beyond-school/>

Mason, R. & Weller, M. (2000). Factors affecting students' satisfaction on a web course, *Australian Journal of Educational Technology*, 16(2), 173–200. Retrieved from <http://www.ascilite.org.au/ajet/ajet16/mason.html>

McAndrew, P. & Scanlon, E. (2013). Open Learning at a Distance: Lessons for Struggling MOOCs, *Science*, 342(6165), 1450–1451. <http://dx.doi.org/10.1126/science.1239686>

MOOCs @ Edinburgh Group. (2013). *MOOCs @ Edinburgh Report #1*. Retrieved from <https://www.era.lib.ed.ac.uk/handle/1842/6683>

Rodriguez, O. (2013). The concept of openness behind c and x-MOOCs (Massive Open Online Courses), *Open Praxis*, 5(1), 67–73. <http://dx.doi.org/10.5944/openpraxis.5.1.42>

Roy, R., Potter, S. & Yarrow, K. (2008). Designing low carbon higher education systems: Environmental impacts of campus and distance learning systems. *International Journal of Sustainability in Higher Education*, 9(2), 116–130. <http://dx.doi.org/10.1108/14676370810856279>

The Open University. (2014). *What are CAT points or credits?* Retrieved from <http://www.open.ac.uk/study/credit-transfer/faqs#n75259>

Tilbury, D. (2011). Sustainability in Higher Education: A global overview of Commitment and Progress. In *Higher Education in the World 4: Higher Education's Commitment to Sustainability: from Understanding to Action*. GUNI. Barcelona: GUNI, Palgrave Macmillan. Series: GUNI Series on the Social Commitment of Universities Global University Network for Innovation.

Universities UK. (2013). *Massive open online courses: higher education's digital moment?* Retrieved from <http://www.universitiesuk.ac.uk/highereducation/Documents/2013/MassiveOpenOnlineCourses.pdf>

University of London International Programmes. (2013). *Massive Open Online Course (MOOC) Report 2013*. Retrieved from http://www.londoninternational.ac.uk/sites/default/files/documents/mooc_report-2013.pdf

Weller, M. J. (2000). Creating a Large-scale, Third Generation, Distance Education Course. *Open Learning*, 15(3), 243–252. <http://dx.doi.org/10.1080/713688403>

Weller, M. & Robinson, L. (2001). Scaling up an Online Course to Deal with 12,000 Students, *Education, Communication and Information*, 1(3), 307–323. <http://dx.doi.org/10.1080/14636310120117112>

Yuan, L. & Powell, S. (2013). MOOCs and disruptive innovation: Implications for higher education. *eLearning Papers*, 33. Retrieved from <http://openeducationeropa.eu/en/download/file/fid/27007>